Environmental Windows as Emerging Issues in Europe

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The National Academy held a workshop in Washington in March 2001, resulting in the recently published "A Process for Setting, Managing and Monitoring Environmental Windows for Dredging Projects" (NAS 2002). The author of this paper was invited to participate in the workshop and this provided a useful opportunity to learn how the concept of environmental windows was working in practice in the US as well as contributing something of the European experience to the working group discussion sessions. One year later this PIANC workshop now gives the opportunity to further review the concept and examine how it is emerging in Europe.

It would be arrogant in the extreme for this author to claim to represent Europe in the views expressed here. However, through involvement in the Environment Steering Committee (ESC) of the Central Dredging Association (CEDA) and the PIANC Environment Committee (Envicom) the author has had a number of opportunities for discussion across a broad spectrum of expertise and experience in countries in Europe. A number of individuals have contributed directly to the views expressed here.

One factor is common in all of the comments, that there are inherent problems in the concept which may not only unreasonably restrict dredging operations (with consequences for social and economic costs) but may actually increase the risk of environmental harm. These comments are discussed later in the paper.

The Preface of NAS (2002) states that "Environmental windows are those periods of the year when dredging and disposal activities may be carried out because regulators have determined that the adverse impacts associated with dredging and disposal can be reduced below critical thresholds during these periods. Environmental windows, therefore, are used as a management tool for reducing the potentially harmful impacts of dredging activities on aquatic resources." Accepting this definition, for the moment, it focuses attention on identification of what the potential impacts are and what the critical thresholds are. The definition does not focus on the need or importance of the dredging project. Step 2D of the Process in NAS (2002) does recognise that these aspects need to be evaluated but states that "the template is designed for federal projects that have been pre-approved and for which funds have been appropriated." This would appear to create an adversarial situation, the need for dredging having already been firmly established, the environmental lobby may well see themselves as the defenders against the attack of the dredgers. At the same time the dredgers are likely to cast themselves in the role of the defenders of common sense against the unreasonable demands of the environmental lobby. Indeed such adversarial discussions took place in the plenary sessions of the workshop.

Dickerson et al. (1998) has defined Environmental Windows associated with dredging as temporal constraints on operations such that sensitive resources or their

habitats may be protected from potentially detrimental effects. The windows are based on the assumption that potential conflicts or detrimental effects may be avoided if dredging or the placement of material is prevented during times when biological resources are most sensitive to disturbance.

This definition too requires a good knowledge of the environmental effects of dredging, which, it has to be admitted, is poor both in the US and in Europe. Because of this lack of knowledge the present climate of opinion demands that a precautionary approach be adopted, ie an assumption is made that unless dredging is prevented environmental damage will occur. Hopefully, in application, there would be at least a suspicion that there will be damage, before the approach is adopted and a restriction imposed.

In the USA the concept of Environmental Windows was introduced about 30 years ago and now about 80% of civil and maintenance dredging works are confined to specific periods of the year.

In Europe, until recently the majority of dredging operations have taken place all year round. However since the introduction of the EU Directives for the conservation of Natural Habitats and the protection of birds (Habitats Directive and Birds Directive) the effects of dredging operations have and are being considered in more detail leading to the idea of introducing the concept Environmental Windows.

Because the concept is in its infancy in Europe there is little experience to report and, inevitably, Europe has looked to the US experience to see what can be learned from it. This paper therefore focuses on how the American model might work in Europe. Two cases, one in Germany and one in the UK are briefly discussed. Some comments are also made with regard to the situation in Portugal before listing some general conclusions.

Potential impacts caused by dredging or disposal operations include:

- physical disturbance of nesting and spawning, destruction of habitats, especially
  - disturbance of fish spawning habitats
  - physical removal of benthic faunal communities
  - physical removal of protected plants
  - disturbance of fish and benthic faunal feeding habitats
- detrimental effects of suspended sediments, turbidity and sedimentation, especially
  - disturbance of fish spawning and nursery habitats
  - disturbance of fish larval development
  - effects on the behaviour of migrating fishes
  - effects on feeding of larval, juvenile and adult fishes
  - reduction of fish fitness and production, enhancement of mortality rate
  - burial of benthic fauna communities
  - disturbance of benthic fauna development
  - enhancement of photosynthetic oxygen production of plankton algae
  - burial of benthic plants

degradation of water quality, especially in zones with low energy and in waters with sediments with high organic content

impairment of fish larval development
impact on adult fishes (e. g. bioaccumulation)
impact on benthic organisms
enhancement of algal growth

hydraulic entrainment

effects on juvenile and larval fishes
effects on benthic fauna

disturbance of nesting and breeding activities by noise

disturbance of navigation

disruption of recreational activities

During disposal activities, the most commonly cited reason for environmental windows is the potential detrimental impact to anadromous fishes.

Environmental Window Assessment Procedure

This section of the paper refers to the technical evaluation itself rather than the step by step consultation process described in NAS (2002)

LaSalle et al. (1991) and Ault et al. (1998) recommended the following concept for evaluation of environmental windows:

Identification of critical periods:

At first, target populations for protection have to be determined. Critical times of development, and main time of growth, breeding, foraging, rearing, or migration have to be identified.

Risk assessment:

In periods of high biological activity assessment of the potential impacts of dredging or dredging disposal on resources of concern is required. Following operational characteristics are important:

Distance of disposal area to sensitive biological habitats:

A concern about possible environmental impacts occurs if the project is located in the vicinity of sensitive biological resources, especially nesting, spawning, and feeding grounds.

Distance to fish migrations:

In tidal waters, fish production significantly depends on anadromous fish migrations.

Sediment transport characteristics:

Potential impacts of dredging operations on benthic biological communities increase if sediment transport characteristics of project area favour sedimentation instead of resuspension. Planktonic life stages, e.g. fish larvae, exhibit great susceptibility to enhanced suspended sediment concentration.

Sediment transport characteristics are mainly influenced by hydrodynamic and geomorphological conditions of project area as well as composition and structure of the suspended material.

Relation to natural dynamics of water quality

In addition, the environmental impacts of disposal operations increase if concentrations of suspended sediments, nutrients and dissolved oxygen are expected to exceed natural concentration maxima or minima for that season. It can be expected that the existing biota is adapted to natural changes but might react to abbreviations from the normal range of variations

USACE District responses confirmed that dredging projects are often delayed and, in rare cases, cancelled because of restrictions.

The development of seasonal restrictions, which are environmentally and economically acceptable, requires a risk assessment with regard to a broad spectrum of project and site specific conditions. Thus, for each individual dredging or disposal project careful considerations of operational characteristics as well as physical, geomorphological, hydrodynamic, and biological attributes of the region are necessary.

The evaluation of environmental windows for individual dredging projects is frequently handicapped by a lack of information on environmental impact. In tidal waters, field studies on the effects of dredging or dredging disposal on biological resources are rare depending on strong dispersion of suspended sediments by tidal current and high natural dynamics of biological communities. Thus, no standardised tools for assessing the actual risk to resources of concern exist.

Discussion

Many areas of dredging operations are either in, or very close, to designated areas under the various European Directives and as such there is a legal obligation to ensure that activities are carried out in a way that do not cause detriment to features for which the areas have been designated. Features include flora, fauna, specific habitat types including estuaries as a whole. In many cases the designations have been made in the knowledge that routine dredging operations have been undertaken for considerable periods of time.

There are often arguments that taking dredged material from the system affects the sediment balance and therefore has a detrimental effect on the designated area. If this is true then under the legislation the existing dredging practice should cease. To accommodate the legislation, suggestions have been made to re-deposit the material within the system, however this can also be opposed as it can have negative impacts in its own right and therefore has its own impacts that should be mitigated for.

The introduction of Environmental Windows using the existing American 'model' may not be feasible at many locations and has the potential to close a number of ports or require excessive over dredging to provide a sufficient siltation buffer to overcome the periods of dredging restriction. Thus in the latter case it is possible that the introduction of periods of no dredging would substantially increase costs, cause a greater intensity of dredging, perhaps needing an increase in size or number of vessels and cause morphological changes which could have long term negative impacts. In such cases it is possible the introduction of specific windows could actually cause detriment rather than prevent detriment.

Surveys in America have shown that many Environmental Windows have been set based on the perceived impact of dredging operations on a particular species rather than monitoring actual effects. Some studies have shown that the dredging has no measurable impact yet the windows have still been imposed. In such cases the restriction is unnecessary and only causes increased costs, potential inefficiency and as indicated above the potential greater impact on features in the longer term.

The window setting process in many areas is also not straight forward. Different species of flora and fauna may be present near to, or pass through, dredging locations and often the crucial periods for each are different and often the cumulative effect would result in an all year round restriction. In such cases a prioritisation process is required which is unlikely to be an easy decision particularly if there is only limited information available on actual likely impacts. Thus Environmental Windows do not protect the environment as a whole. Once a window has been set a decision is required as to whether dredging in that period can take place without any further restriction or whether mitigation measures are still required to help protect the other species which are likely to be affected, to a lesser extent during that period.

A potentially better approach for both the environment and the necessary requirement for dredging would be to base decisions around a weight of evidence approach using data and scientific knowledge to undertake a risk assessment of the potential impacts, with clearly defined specific monitoring to provide a feedback for future assessments. This should give a system for continuous improvement.

In this context the concept for evaluation recommended by LaSalle et al. (1991) and Ault et al. (1998). If all the impacts for the excavation and disposal process are considered it could be argued that most impacts can be traced back to perhaps three route causes: direct removal of the resource with the dredged material; disturbance/supply of material to the water column; and noise. Thus providing ways to minimise these causes will reduce/eliminate a number of impacts.

The first can only be alleviated by reducing the dredging requirement. It could be argued that more frequent dredging for smaller amounts may not allow time for benthic recruitment (for example) therefore the removal would be limited. Applying say a 3 month dredging window may allow time for recruitment and therefore each dredge would potentially remove more of the resource.

The cause with the most potential for impact is the supply to the water column since this affects the suspended sediment content, turbidity, the means of remobilising contaminants and nutrients, and determines the potential for smothering affects.

The predicted extents of impact and magnitudes can then be compared to the resource location and thresholds of particular parameters (if established) for harm of the resource under consideration. If thresholds of harm are not known the range in natural variation must be an indicator of what the resource can withstand. In such cases a dredge management plan can be devised based around tidal cycles, lunar and seasonal cycles to minimise impacts with online monitoring (e.g Dissolved oxygen, turbidity etc) and agreed procedures should situations of concern arise.

In any risk assessment the scale of the operation must be considered with respect to the size of the water body, the rate of dredging and relocation, and the location of works relative to the main flows. For example, dredging an enclosed dock or a marina embayment is likely to be away from the main estuary or river flows therefore is unlikely to impact on migrating species therefore there is a low risk of impact to this resource. However the dredging of a navigation channel taking up much of the cross section of the water body could cause considerable risk. Thus individual dredge and disposal operations should be considered in their own right. A cumulative assessment may be required if several operations are planned in a small area at a similar time.

This concept relies on working with the environmental processes as a whole and only causes restrictions when there is an actual risk of detriment rather than a perceived risk. It should also identify which resource is of main concern for which a dredge management plan can be devised. Should the risk still be considered too high then a dredge exclusion period can still be imposed.

The emphasis therefore has changed from the environmental window being set up front when it may not be necessary to using it as a last resort when evidence suggests the risk of impact is too high. Also where there are different projects in area which may be of different type and scale the method may allow one but not the other rather than complete exclusion.

Allowing dredging to occur throughout the year in this controlled manner helps to reduce the magnitude and duration of effects at the expense of increased frequency.

Mitigation Methods

There is a strong feeling in Europe that technologies to control the environmental effects of dredging are more advanced in Europe than in the US. Thus, in applying the windows concept in Europe, there should be more flexibility allowed in defining the “safe” period. The series of Guidelines on Environmenal Aspects of Dredging includes one on the technologies available (CEDA, 1998).

The extent of impact can be managed by the selection of equipment, control of rate of production, restriction of overspill, all integrated with a knowledge of the local hydrodynamics (from field measurements and modelling) and the natural variability of the system which determines the overall extents of the impacts and magnitudes.

Disposal operations also place material into the water column. Again the extent of impacts can be minimised by using the variation in the hydrodynamics to help control the extent and magnitude of impacts to acceptable levels.

Hamburg Experience

In Hamburg, seasonal restrictions on disposal (but not dredging) operations were formulated in an attempt to avoid potential effects of dredged material disposal on sensitive biological resources. Dredging operations are restricted from April until October in the tidal area of the River Elbe upstream of Hamburg Harbour. The reason is the very low oxygen content in the river in summer, very often near or below the level critical to fish life. The disposal of fine grained sediment would lead to oxygen consumption, lowering the oxygen levels even further.

The River Elbe is biologically characterised by a high fish production, a high benthic faunal population density, and species diversity. In addition, oxygen deficits regularly occur in the tidal regions of the river Elbe during periods of high biological activity. In the tidal Elbe, oxygen deficiency mainly results from reduced biogenic oxygen production of planktonic algae, and increased oxygen consumption by decomposition of suspended matter. At Hamburg Harbour and downstream, water depths and turbidity are increased. Accordingly, the light conditions deteriorate dramatically. Thus, in the tidal Elbe upstream of Hamburg Harbour biogenic oxygen production may be possible only at water surface.

Environmental impacts of disposal operations have been investigated extensively in Hamburg since 1994. Various studies have focused on sediment transport, effects on water quality, and benthic communities. In addition, literature on impact of disposal operations on biological organisms and oxygen regimes of tidal waters were studied.

In the area of disposal, significant impacts of disposal operations on both concentration of suspended sediments and oxygen regime could be detected in the near field in some cases. Generally these were short-term effects but potential long-term effects can not be excluded. The natural variation of suspended matter in the tidal Elbe was high, so it was impossible to examine further the transport and final destination of the dredged material.

The investigations showed that impairments of biocenosis might occur due to the relocation of dredged material with associated high input of solids and variation of the water quality in some parts of the river, especially in shallow waters near the river bank. Here fish as well as benthic communities are living and have important nesting, spawning, and feeding grounds.

It was shown that the effects on oxygen content in the river and on the biocenosis mainly depend on the flow characteristics (discharge) and the composition of the dredged material. These effects can be minimised by moving the disposal site slightly.

It was concluded from this work that the environmental window presently applied was longer than it needed to be. More measurements, better understanding and new mitigation measures applied to the disposal have resulted in better public acceptance and a small opening of the window.

Port of London Experience

As part of their work in developing an environmentally responsible maintenance dredging strategy for the River Thames, the Port of London Authority (PLA) have been considering the extent to which the philosophy underlying the environmental windows concept is relevant, both to their needs and to the expectations of their stakeholders.

The PLA has a number of reservations about environmental windows for dredging, particularly having investigated the application of the concept in the US. In this context, the following points summarise the key considerations of the PLA in determining whether, and if so how, the concept might be applied satisfactorily on the River Thames.

Any decisions on environmental windows should be informed by science rather than speculation. It is important to avoid the situation, which appears to have happened historically in the US, where windows were determined in an overly precautionary or under-informed way, and have subsequently proved difficult to amend.

Before making any decisions about possible restrictions on dredging, it is essential both to understand the likely mechanism for a particular potential effect, and to set any likely impacts in the correct context (for example, in terms of the proportion of the resource likely to be affected and the ability of the population to satisfactorily recover from the loss of a number of individuals). It is not reasonable to assume that, simply because a species is present at a particular time, there will necessarily be an adverse impact.

The option of reducing potential impacts to acceptable levels via modifications to dredging operations (eg. reducing overflow) should always be investigated thoroughly before discussions about possible environmental windows are initiated.

If windows are required, and wherever it is scientifically possible and cost-effective to do so, they should be flexible - ie. the start and end points should be triggered by monitoring - rather than setting a precautionary time period which may prevent dredging for longer than is actually necessary.

If windows are to be set, the process for doing so must include the ability to revise existing windows as new information becomes available.

Portuguese Experience

In Portugal it is seen that problems may arise in applying Environmental Windows, mainly when the planning is not perfect and the economic resources are not adequate.

Certainly the principles could be implemented in certain dredging works (perhaps in routine maintenance dredging in Ports) but it can be at the same time a dangerous management tool.

Environmental Windows have not been introduced in a formal way but in some projects an attempt is made to adjust the periods of maximum activity to suit conditions, chiefly when dredging occurs near a sensitive area (because of fauna and flora preservation) or when the disposal activity could affect the normal use of the nearby beaches, i.e. June September.

The general aim is to prevent :
physical disturbance of nesting and spawning, destruction of habitats;

detrimental effects of suspended sediments, turbidity and sedimentation;

degradation of water quality, especially in zones with low energy and in waters with sediments with high organic content;

hydraulic entrainment;

disturbance of nesting and breeding activities by noise;

disturbance of navigation.

These aspects have been considered and some preventive measures were adopted in Portuguese estuaries (Cávado, Mondego, Tejo, Sado and Guadiana River) and in coastal lagoons areas (Aveiro, Faro).

Until recently the majority of dredging operations have taken place all year round. However, since the introduction of the EU Directives for the conservation of Natural Habitats and the protection of birds (Habitats Directive and Birds Directive) the effects of dredging operations are expected to be considered in more detail leading to the idea of evaluating the implications of the implementation of Environmental Windows.

In many case the transport of dredged material and the disposal activities have been restricted to the falling tide period, though this measure is not easy to enforce. Also in many cases work is not carried out at night, so there is a "daily window". To these gaps certainly we have to add the "weather window". Thus the factors are cumulative.

"night window" + "weather window" + "tidal window "+" seasonal window".

It is possible that the introduction of more windows could actually cause detriment rather than prevent harm. Certainly, for a given location, this would originate the intensification of dredging activities in a few months, since, because of severe social and economic consequences, it is not admissible to think of closure of the ports.

Another consideration is that in less developed countries large dredges and disposal equipment are not close at hand to carry out the work intensively. The pressure is increased because WINDOWS in many countries will be at the same season, which has consequences for costs.

The introduction of Environmental Windows using the existing American 'model' may not be feasible at many locations and has the potential to close a number of ports or require excessive over dredging to provide a sufficient siltation buffer to overcome the periods of dredging restriction.

Concluding Remarks

Whilst Environmental Windows appears to be a simple tool to limit the environmental impacts, people directly involved in environmental dredging issues in Europe are concerned at the severity with which it is being applied in the US and would seek to avoid such problems in Europe. The concept places a great deal of pressure on those promoting a dredging operation to prove that it will not cause harm to the environment. Scientifically this is a very difficult thing to do for a number of reasons:

1. It is difficult to establish the baseline because few, if any things in nature exist in a steady state. This implies monitoring many years or life cycles of sensitive species and correlating their well being with other naturally varying parameters.

2. It then implies a knowledge of which parameters in dredging actually cause harm. Taking turbidity as an example, only a few attempts have been made at total measurement of the amount of sediment released during dredging. They are inherently very difficult to make because of the temporal and spatial variations in suspended solids concentration in three dimensions, not to mention the processes of settling, resuspension, turbulent mixing, hydrodynamic advection etc.

3. Next it is necessary to predict, again using turbidity as an example, the effects on the sensitive species. With a few exceptions very little has been done in the field to verify predicted impacts and laboratory experiments in general have not been conclusive.

All of this results in critical standards or windows being set based on something that is not yet capable of being measured or predicted and the actual environmental impact of which is hardly known.

The consequences of such restrictions are:

- Increased dredging costs arising from inefficient ways of working.
- The need for an extremely large fleet of dredgers because windows in many locations will be the same season. This would result in there being an over capacity in the no-dredging season and an under capacity in the dredging window. This too has consequences for costs.

- More intensive dredging in the limited period when it is allowed is likely to mean bigger dredgers or more of them, faster working, higher rates of sediment release etc. which could lead to more environmental damage.
- More use of overdredging to provide capacity for siltation for the period when dredging is not allowed which could also lead to more overall environmental damage.
- In extreme cases it could result in the closure of ports, with severe social and economic consequences

The author concludes that from a European perspective the Environmental Windows concept should be seen as a tool of last resort. Before it is applied, all reasonable attempts should be made to identify whether there is really likely to be any significant adverse effects and when mitigation methods are not sufficient to reduce the risk to an acceptable level.

In the face of these things the only solution would seem to be research to gain a better understanding of the actual effects of dredging as opposed to the perceived effects, and further investigation into ways of mitigating those impacts. Meanwhile there is an urgent need for technically informed and less adversarial dialogue between the dredgers and the regulators.

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